

1. A device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment comprising

operator communication means for transmitting collision information to said operator

signal transmitter means for transmitting an electromagnetic signal to said objects;

signal receiver means for collecting reflected electromagnetic signals from said objects and developing three-dimensional object data;

output electronics means for conditioning and transferring said data;

data processor means for receiving said conditioned data, storing the data, computing parameters indicative of potential collisions from said data, deciding the likelihood of potential collisions from said parameters and sending control signals to the drive electronics and said operator communications system;

drive electronics means for controlling the timing and biasing of said signal transmitter, said signal receiver and the said output electronics.

2. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 wherein said electromagnetic signal is a laser pulse.

3. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1 and 2 wherein the signal transmitter comprises;

means for producing one or a plurality of laser pulse;

optics means for concentrating the laser light in a solid angle consistent with the power of the laser and useful range of the invention;

laser detector means for detecting the emission of the laser pulse and transferring a signal representative of that information to the said drive electronics.

4. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 2 and 3 wherein the signal receiver comprises;

optics means for collecting said reflected laser light concentrating the laser light on sensor means;

sensor means for converting said electromagnetic signals to an electrical current;

unit cell electronics means for storing signals corresponding to said electrical current in a two-dimensional array, the two-dimensional array corresponding to the two dimensional surface of the said objects, with information indicative of the time of return of the said reflected electromagnetic signal from the said objects;

output driver electronics circuitry means for transferring said stored signals to said output electronics.

5. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 2, 3 and 4 wherein the sensor means includes electron amplifier means.

6. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 2, 3, 4 and 5 wherein the said electron amplifier means is a microchannel plate.

7. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 2, 3, 4 and 5 wherein the said electron amplifier means is a solid state detector array used in an impact ionization mode.

8. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 2, 3 and 4 wherein the sensor means includes detector means.

9. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 2, 3, 4 and 8 wherein the said detector means is a photocathode.

10. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 2, 3, 4 and 8 wherein the said detector means is a solid state detector array.

11. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 2, 3 and 4 wherein the sensor means includes one or a plurality of readout integrated circuit means.

12. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 2, 3, 4 and 11 wherein the said integrated circuit means includes an array of unit cell circuits.

13. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 2, 3, 4, 11 and 12, wherein the said unit cell circuits includes circuit means for developing data indicative of the flight time of a laser pulse to a portion of an object and back to the device.

14. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 2, 3, 4, 11, 12 and 13, wherein the said circuit means for developing data indicative of the flight time of a laser pulse to a portion of an object and back to the device includes a digital range counter.

15. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 2, 3, 4, 11, 12 and 13, wherein the said circuit means for developing data indicative of the flight time

of a laser pulse to a portion of an object and back to the device includes analog, pulse-shape-sampling circuitry.

16. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 2, 3, 4, 11, 12 and 13, wherein the said circuit means for developing data indicative of the flight time of a laser pulse to a portion of an object and back to the device includes Schmitt Trigger circuitry.

17. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 2, 3, 4, 11, 12 and 13, wherein the said circuit means for developing data indicative of the flight time of a laser pulse to a portion of an object and back to the device includes Transimpedance Amplifier circuitry.

18. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 wherein said operator communication means includes a flat panel display and/or a windshield projection.

19. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 wherein said operator communication means are verbal commands.

20. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 wherein said operator communication means includes a warning buzzer or alarm.

21. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 wherein said output electronics means includes analog to digital converters.

22. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 wherein said output electronics means includes gain and offset correction circuitry.

23. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 wherein said output electronics means includes circuitry for implementing range calculations using said data.

24. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1 and 23 wherein said output electronics means includes circuitry for implementing time of impact calculations.

25. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1, 23 and 24 wherein said output electronics means includes circuitry for implementing collision avoidance decisions.

26. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 wherein said data processor means includes a digital computer.

27. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 wherein said data processor means includes range computation software.

28. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 wherein said data processor means includes time-of-impact computation software.

29. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 wherein said data processor means includes object recognition software.

30. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1 and 29 wherein said object recognition software is three-dimensional object recognition software.

31. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 wherein said data processor means includes collision-avoidance calculation software.

32. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 wherein said data processor means includes minimum-damage calculation software.

33. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 wherein said drive electronics means includes a master clock.

34. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 which also comprises environmental sensor system means for obtaining parameters relevant to collision avoidance or damage minimization decisions.

35. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1 and 34 wherein said environmental sensor system means includes a precipitation monitor.

36. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1 and 34 wherein said environmental sensor system means includes a vehicle speed indicator.

37. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1 and 34 wherein said environmental sensor system means includes a coefficient of friction indicator.

38. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 which also

comprises automatic control means for implementing collision avoidance or damage minimization maneuvers.

39. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 which also comprises passenger sensor means for obtaining passenger parameters that can be used for collision avoidance maneuvers, damage minimization maneuvers and optimal activation of passenger protection devices.

40. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1 and 39 wherein said passenger sensor means includes passenger position indicators.

41. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1 and 39 wherein said passenger sensor means includes passenger weight indicators.

42. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1 and 39 wherein said passenger sensor means includes means for activating, adjusting or modifying passenger restraints.

43. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 which also comprises operator interface means for inputting information into the said data processor means.

44. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1 and 43 wherein the said operator interface means includes a flat panel display.

45. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 wherein the said data processor means includes database means.

46. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 30 and 45 wherein the said database means includes vehicle identification parameters which can be used by the said object recognition software.

47. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 31 and 45 wherein the said database means includes vehicle maneuverability parameters which can be used by the said collision-avoidance calculation software.

48. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 wherein said electromagnetic signal is a continuous laser.

49. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1 and 48 wherein said signal receiver can process Doppler-shifted laser signals.

50. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 1 wherein said electromagnetic signal is a microwave signal.

51. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 2, 3, 4, 5 and 8 wherein the said electron amplifier means is a solid state detector array used in an impact ionization mode.

52. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 2, 3, 4, 11 and 12, wherein the said unit cell circuits includes circuit means for sequentially integrating and storing the current input to the unit cell from the detector.

53. The device for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 1, 2, 3, 4, 11 and



12, wherein the said unit cell circuits includes circuit means for converting the current input from the detector to a time dependent voltage and sequentially sampling and storing this voltage.

54. A method for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment, where the environment may include obscuration, comprising the steps of:

generating a series of pulses of light;

transmitting said light into said environment;

collecting light from said environment during the time of transmission and reflection of said light from said objects;

providing electrical signals from a plurality of positions on the objects with a single light pulse,

storing said electrical signals on a plurality of unit cells corresponding to the said plurality of positions on said objects,

providing signals from said storage means,

converting the signals stored on said storage means to three dimensional images of the objects;

processing said images to calculate the likelihood of object collisions with said vehicle;

communicating the results of said calculation to the vehicle operator

55. The method for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 54, wherein the electrical signals correspond to the transit time of the light to the object positions and back to the transmitter.

56. The method for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 54, wherein the said processing includes calculation of collision avoidance maneuvers.

57. The method for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 54 and 56, wherein the said communication includes communication of collision avoidance maneuvers.

58. The method for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claim 54, wherein the said processing includes calculation of minimum-damage maneuvers.

59. The method for warning the operator of a stationary or moving vehicle of potential collisions with objects in his physical environment of claims 54 and 58, wherein the said communication includes communication of minimum-damage maneuvers.

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